REMARKS

Claims 1-39 were pending and presented for examination in this application. In an Office Action dated December 14, 2007, claims 1-39 were rejected. No claims have been amended. Claims 1-39 are pending.

Interview Summary

On May 6, 2008, in a telephone interview, the Examiner and the undersigned attorney discussed the rejections based on Hui (US 6,654.417 B1) and Hurst (US 6,763,067), as well as the applicability of the Lightstone reference (US 2005/0084007 A1).

Response to Rejection Under 35 USC §102(e)

The Examiner rejected claims 1-15 under 35 USC §102(e) as anticipated by Hui (US 6,654.417 B1). This rejection is respectfully traversed.

Claim 1 recites:

> A method for robust single-pass variable bit rate video encoding, the method comprising:
> **determining a buffer size** for keeping track of over/underused bits generated during the encoding of a video sequence, the buffer size being a function of at least a target bit rate for the video sequence and a length of the video sequence;
> initializing the buffer to a default initial fullness; and
> for each frame of the video sequence, performing the following steps:
> allocating a number of bits to the frame;
> **determining a quant** with which to encode the frame, **the quant being a function of at least the buffer's fullness;**
> encoding the frame according to the determined quant; and
> **updating the fullness of the buffer** based on any over/underused bits for the frame.

The claimed invention relates to robust single-pass variable bit rate encoding. The claimed invention allows a video encoding system to encode a video sequence at a target average bit rate while still maintaining a substantially consistent quality across the video sequence as a whole. More specifically, an encoding manager determines a buffer size for keeping track of over/underused bits generated during the encoding process. The encoding manager uses a function of a target bit rate and a length of the video sequence to be encoded to determine the size of the buffer. For each frame of the video sequence, the encoding manager determines the quantization value ("quant") associated with the frame and encodes the frame according to its associated quant. The quant is determined according to the buffer fullness and the buffer fullness is updated based on any over/underused bits generated from encoding the frame.

Hui does not disclose the invention of claim 1. Hui discloses a single variable bit rate encoding procedure using a target encoding quality and a bit rate determined by the complexity of the video sequence. *See* Hui, Abstract. More specifically, in Hui, before encoding an input picture sequence, an encoder is set with maximum and minimum bit rate of target application and a target quality for encoded pictures. After encoding a picture or a certain number of pictures, the encoding quality (quality of the encoded pictures) is measured against the target quality and the target encoding bit rate is adjusted based on the comparison. The encoder will then re-adjust its rate control system with the new target bit rate and continue to encode the rest of the input sequence. *See* Hui at col.8:12-37.

Hui does not disclose determining a buffer size using a target bit rate and a length of the video sequence to be encoded. The examiner cited Hui at col. 7:53-57 as evidence that Hui discloses this buffer size determination feature. However, the above citation is directed to a video buffer verifier (VBV) "which is a virtual model of an input buffer of an external decoder,"

and Hui does not disclose determining a buffer size as a function of a target bit rate and a length of the video sequence as claimed. In addition, in Hui, the frame bit-count module 114 containing the VBV computes "number of bits generated by previously encoded I-, P-, B-picture," not the "over/underused bits generated during the encoding video sequence" as claimed. *See* Hui at col. 7:14-16.

Second, Hui does not disclose determining a quant to encode a frame with quant being a function of at least of the buffer fullness, as claimed. Hui discloses selecting a target quality for encoded pictures before encoding a frame and compares the encoded picture quality after encoding the frame against the target quality. The target quality, QS_{target}, is defined as the target reference quantization stepsize, and the encoded picture quality, $QS_{average}$, is determined by the average value of the reference quantization stepsize. *See* Hui at col. 9:48-67. Based on the comparison result of QS_{target} and, $QS_{average}$, Hui adjusts the target bit rate. *See* Hui at col. 10:9-25. Thus, Hui does not disclose determining a quant to encode a frame in response to the buffer fullness.

For at least these reasons claims 1, 16, 24 and 32 are patentably distinguishable over the cited reference, and the rejection should be withdrawn.

The dependent claims are also patentable over Hui, both because each depends from patentable independent claims, respectively, and because each also recites its own patentable features. For example, dependent claim 6 recites a plurality of encoding parameters for each frame type, such as a base quant envelope, a base quant envelop control, ratio information, a frame complexity parameter, which are used to initialize a frame to be encoded. Taking **base quant envelope for each frame type** as an example, the based quant envelope for each frame type is a normalized running average of the quants used to encode frames of that type. The base

quant envelope for each frame type can be used to control variation in the quant used to encode specific frames of that type. Details support can be found in Specification at ¶¶ [0022]-[0023]. Therefore, Applicants respectfully submit that claims 1-15 are not anticipated by Hui.

Response to Rejection Under 35 USC §103(a)

In the 4th paragraph of the Office Action, Examiner rejected claims 16-39 under 35 USC §103(a) as unpatentable over Hui (US 6,654.417 B1) in view of Hurst (US 6,763,067). This rejection is respectfully traversed.

In the rejection of claims 16-39, the Examiner acknowledges that Hui fails to disclose a computer system to implement the features claimed in Hui, and asserts that the Hui system, "now modified to be implemented as a computer system as shown by Hurst, has all the features of claim 16." First, Hui does not disclose a computer system corresponding to Hui's coding method. In contrast, claim 16 recites a computer system adapted to perform functions similar to those of claim 1. As such, the claimed computer system comprises means for determining a buffer size for a video sequence as a function of at least a target bit rate and a length of the video sequence. For each frame of the video sequence, the computer system has means for determines the quantization value ("quant") associated with the frame and encoding the frame according to its associated quant. The quant is determined according to the buffer fullness and the buffer fullness is updated based on any over/underused bits generated from encoding the frame. As such, Hui does not disclose a computer system as disclosed in claim 16.

Second, Hui's coding method cannot be implemented by Hurst. Hurst discloses a process to convert an exiting input compressed video bitstream into an output altered compressed video bitstream having a different bit rate and/or representing different imagery from the input

bitstream. *See* Hurst at Abstract and col.1:20-23. In Hurst, the VBV model is used to derive arrival margin for a frame, which is defined as the amount of time between when the last bit of a frame has entered the buffer (i.e., VBV model) and when that frame is removed from the buffer. *See* Hurst col.2:44-55. Thus, Hurst dose not disclose how to determine a buffer size as a function of a target bit rate and a length of the video sequence as claimed.

In Hurst, rate control 226 generates the Quantization Re-scale Factor (QRF) based on the comparison of input arrival margin 220 of current frame n, and output arrival margin 224 of current frame n. The QRF is used by re-encoder to scale quantization data recovered from the input bitstream for next frame, i.e., frame n+1. *See* Hurst col.8:15-28 and col. 2:47-52. Thus, Hurst does not disclose determine a quant as being as function of buffer fullness and encode the **current** frame according to the determined quant as claimed.

Finally, the incompatible input between Hurst's system and Hui's system prevents the implementation suggested by the Examiner from happening. More specifically, the input to Hurst's system is an exiting input **compressed video bitstream** while the input to Hui's system is **a sequence of video pictures**. *See* Hurst at Abstract and Hui at Abstract. As known to a person of ordinary skill in the art, a sequence of video pictures to an encoder is commonly called **"raw"** video pictures in contrast to the **"compressed"** or **"encoded"** video stream processed by an encoder with or without rate control. To use Hui's method in combination with Hurst's system, Hurst's compressed video bitstream has to be **fully** decoded by Hurst's decoder 202 to generate a decoded input stream, i.e., a sequence of pictures, to be used by Hui. However, the encoding process described by Hurst at col. 5:28-59 to generate Hurst's input stream is lossy encoding as known to a person of ordinary skills in the art. Thus, Hurst's decoder 202 generates the decoded input stream, which is not raw video pictures as required by Hui's system.

Thus, the combination of teaching of Hui's rate control for raw input video sequence and Hurst's rate control for bitstream re-encoding does not teach or disclose the features of determining a buffer size for single-pass rate control purpose and determining a quant for a frame to be encoded based on the buffer fullness as claimed. Indeed, the combination is improper under MPEP 2143.01(V), since it would change Hui's subject matter: rate control over a sequence of video pictures.

For at least the reasons above, Applicants submit that the pending claims 16, 24 and 32 are patentable over the cited references. Claims 17-23, 25-31 and 33-39 either directly or indirectly depend from claims 16, 24 and 32. These dependent claims also recite additional features not disclosed by the cited references. Thus, Applicants submit claims 17-23, 25-31 and 33-39 are patentably distinguishable over the cited references.

Discussion of Reference Lightstone (US 2005/0084007 A1)

During the telephone interview, the Examiner invited Applicants to place remarks on the record with respect to the applicability of Lightstone as a reference. Lightstone does not remedy the deficiency of both Hui and Hurst. Lightstone discloses a video encoder including a programmable rate controller, which further includes a variable bit rate (VBR) controller, a constant bit rate (CBR) controller and an arbitration logic for selecting one of the two outputs. *See* Lightstone at Abstract. The constant bit rate controller adjusts an "ideal" bit budget based on the difference between the actual VBV fullness and a picture-adjusted "ideal" VBV fullness. The final budget determines the bit allocation and subsequent quantizer assignment for the picture. See Lightstone at ¶ [0054]. This "ideal" VBV buffer fullness represents the steady-sate

fullness of the VBV buffer **under the assumption that the encoder is allocating and generating bits in accordance with the specified constant bit rate**. See Lightstone at ¶ [0058].

First, it is important to appreciate that Lightstone describes a **CBR rate controller**, not a single-pass **VBR** coding method as claim. The differences between CBR and VBR coding systems are apparent to one of ordinary skill in the art. In general, CBR is useful for streaming multimedia content on limited capacity channels since it is the maximum bit rate that matters, not the average. In contrast, VBR varies the amount of output data per time segment. VBR allows a higher bitrate to be allocated to the more complex segments of video frames while less bitrate is allocated to the less complex segments. The average of these varying bitrates represents the uniform overall good quality of the whole video sequence. Consequently, the bit rate control goals are different for VBR and CBR coding systems, and consequently how these approaches are different as well. As such, Lightstone does not disclose the claimed invention.

Second, Lightstone does not teach or suggest a computer method or a system for determining a buffer size for single-pass **variable bit rate control** purpose and determining a quant for a frame to be encoded based on the buffer fullness, as claimed. As discussed above, Lightstone neither discloses using VBV for variable bit rate control nor teaches determining a buffer size as a function of at least a target bit rate and a length of a video sequence. Indeed, using VBV for Lightstone's variable bit rate controller is improper since it would imply that Lightstone would apply VBV to the variable bit rate controller, which is inconsistent with Lighstone's assumption, as VBV is for constant bit rate control for a video sequence.

In sum, the pending claims are patentably distinguishable over the cited references and should be allowed.

The Examiner is invited to contact the attorney listed below in order to advance prosecution.

Respectfully submitted,
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